

ESTABLISHING DEBRIS BURNING RESTRICTIONS BASED ON FIRE DANGER

EXECUTIVE PLANNING

**BY: Jody Gossner, Battalion Chief
California Department of Forestry and Fire Protection
Georgetown, California**

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ABSTRACT

Clearing defensible space around structures in California's wildland creates a great deal of debris that must be disposed of. Burning is the most common method of eliminating the debris yet the burning must only be done when fire danger is not high. The problem that lead to this research paper was that the Amador El Dorado Ranger Unit did not have an adequate way to measure when the fire danger was low enough to safely allow burning.

The purpose of this research paper was to identify a method for evaluating the days determined by the Air Resources Board as burn days, from a fire danger perspective. Evaluative, historical, and descriptive research methodologies were used to answer the following research questions:

1. What are other CDF Ranger Units doing about burn days during hazardous fire weather conditions?
2. What information is available to gain a better understanding of the National Fire Danger Rating System and use it to its full potential?
3. What tools are available for evaluating fire weather and fire danger conditions?
4. What weather conditions allow debris burning in a safe manner?

The procedures used included a literature review, survey of other CDF Ranger Units, and an extensive analysis of historical fire and weather data. The data analysis was conducted using several different computer programs on a personal computer.

The literature review yielded a great deal of information helpful in the project. The results of the ranger unit survey were limited, but the historical data analysis provided the information necessary to establish a cut-off point for when burning should be eliminated.

Several recommendations were made based on the research and data analysis including a cut-off point for debris burning based on fire danger. Continued monitoring of the process and training of personnel at several levels was also recommended.

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INTRODUCTION

State law in California requires homeowners in wildland areas to provide defensible space around their houses. This defensible space involves removing flammable vegetation from around the structures to provide a safety buffer in the event of fire. California's wet winters and warm springs allow an abundance of new growth each year that must be cleared to provide the defensible space. Often the only viable method of disposing of the cleared vegetation is by burning it. Burning of the debris by vast numbers of people living in the state's wildland areas can have a significant impact on air quality.

Debris burning in California is regulated by several different agencies. Primarily, the California Air Resources Board (ARB) regulates what type of material can be burned and on which days burning is allowed. Each county has an air pollution district that determines the specific burning regulations and in some cases, issues burning permits. Permissive burn days are determined by the ARB, based mainly on forecast weather conditions.

The California Department of Forestry and Fire Protection (CDF) regulates how the burning is conducted from a fire safety perspective. CDF has its own burning permit process for those portions of the state designated as State Responsibility Area (SRA). SRA is generally the wildland area of the state, officially those areas of the state where there are resource, range, or watershed values not included in National Forests.

The ARB is primarily concerned with issues of air quality, while CDF's primary concern is with fire safety. This can create a problem, because on the one hand the State requires flammable vegetation be removed from around homes, yet on many of the days

which burning is allowed it may be too hazardous to burn due to fire danger. At times the conditions that allow burning from an air quality perspective pose problems from a fire danger perspective. Wind and vertical mixing of the atmosphere allow smoke to dissipate and maintain good air quality, but can contribute significantly to fire danger.

The purpose of this research paper was to identify a method for evaluating the burn days, as determined by the ARB, from a fire danger perspective. If the fire danger is high then the burning would be eliminated, basically burn status would be changed to a no-burn day. This project did not deal with the process that ARB uses to make its determination of burn status. The air quality concerns of the ARB are a separate issue. This project involved action research, although some aspects of evaluative and descriptive research were involved also. The research questions answered were:

1. What are other CDF Ranger Units doing about burn days during hazardous fire weather conditions?
2. What information is available to gain a better understanding of the National Fire Danger Rating System and use it to its full potential?
3. What tools are available for evaluating fire weather and fire danger conditions?
4. What weather conditions allow debris burning in a safe manner?

BACKGROUND AND SIGNIFICANCE

Amador El Dorado Ranger Unit is one of 21 ranger units that make up the operational components of CDF. Each ranger unit has its own chief and operates with a great deal of autonomy. This paper deals with the issue of permissive burn days within the

Amador El Dorado Ranger Unit only. Amador and El Dorado counties each have their own air pollution control district. Each district sets many of its own regulations. In 1994 El Dorado County Air Pollution Control district banned all burning from July 1 until November 1. The county ban was rescinded in 1997 and the ranger unit wanted to develop a means of restricting burning when fire danger was high. California Public Resources Code allows CDF to suspend burning under the following conditions:

... the menace of destruction by fire to life, improved property, or natural resources is, or is forecast to become, extreme due to critical fire weather, fire suppression forces being heavily committed to control fires already burning, acute dryness of the vegetation, or other factors that may cause the rapid spread of fire. (California Public Resources Code, 1989, § 4423.1)

A concern of management in the ranger unit was that there was no definition of “critical fire weather” or at what point “acute dryness of vegetation” could cause “rapid spread of fire”. In fact, rapid spread of fire was subject to wide ranges of interpretation. A method had to be developed to quantify the reasons for putting a burn ban in effect. The National Fire Danger Rating System (NFDRS) is a management tool, much as its name suggests, for evaluating fire danger. The program had not been used in the ranger unit, and was not well understood. Yet, because of the need to use something to restrict burning on critical fire weather days, NFDRS was chosen. Due to time constraints and limited knowledge of NFDRS a cut-off point for burning was established without sufficient planning.

While rain is unusual during the summer in Northern California, it does occur. Under the cut-off point established in 1997 there were times following rain, or cool weather, when

burning could have been conducted safely yet burning was still restricted. The general public did not understand why they could not burn when it was obviously safe to do so. The credibility of CDF was called into question when burning was restricted, supposedly due to fire danger, yet it was raining. In addition, ranger unit management wanted to provide the homeowners with as much opportunity to burn as possible (C. Anthony, personal communication, September 24, 1998).

The Executive Planning course at the National Fire Academy emphasizes the fact that the public is demanding more accountability from public managers (National Fire Academy, n.d.). While the Executive Planning course focuses on longer term strategic planning it also emphasizes the need for short range planning. Additionally, the course discusses the consequences of no planning. The implementation of the 1997 burn ban criteria within the Amador El Dorado Ranger Unit was undertaken with insufficient planning. By using the concepts of planning presented in the Executive Planning course a better means of evaluating fire danger can be developed.

LITERATURE REVIEW

The literature review was conducted at the LRC of the National Fire Academy, agency libraries of CDF and the United States Forest Service, as well as an extensive search on the Internet. The agency libraries proved to be the most valuable source of information, followed by the information available on the Internet.

The concept of rating fire danger has been under development in the United States since the early 1900s (National Wildfire Coordinating Group [NWCG], 1985). Eight

different fire danger systems were being used in 1954, and in 1958 the United States Forest Service (USFS) began development of a single national fire danger rating system. However, it was not until 1972 that a system actually became available. Bradshaw, Deeming, Burgan, and Cohen (1983) indicated that by early 1977, all Federal agencies and 35 State agencies used the 1972 version of NFDRS.

Following extensive field testing, the program was revised and released as the 1978 National Fire-Danger Rating System. A significant change in the 1978 system was the addition of a live fuel moisture model (Burgan, 1979). Other changes included; the system was made more responsive to drought, increasing the sensitivity of the ratings at lower fire danger ranges, and incorporation of newer technology (Deeming, Burgan, and Cohen, 1977). Anderson (1982) wrote that the NFDRS depends upon an ordered set of weather records. These weather records are used in conjunction with a set of 20 fuel models to provide day-to-day as well as seasonal trends in fire danger. The fuel models are used to represent the many different vegetation types across the country.

“The National Fire-Danger Rating System is a multiple index system developed to provide information about current and predicted fire danger conditions” (NWCG, 1985, p. 2). Andrews and Bradshaw (1997) described the NFDRS as being based on a worst-case approach. Worst-case is used because weather observations, on which the program is based, are taken at the hottest and driest part of the day and often on a southern exposure.

The outputs of the NFDRS are several different numerical indexes and components. These are divided into two groups, those that deal with fire behavior potential and those that deal with fire occurrence (Deeming et al., 1977). The outputs that deal with fire

behavior potential are the Spread Component (SC) and Energy Release Component (ERC). The SC and ERC are further combined to generate the Burning Index (BI). Among the fire occurrence outputs, is the Ignition Component (IC). The outputs have varying degrees of sensitivity in their response to changes in the environment. Because of the varying sensitivity of each output, they each have strengths and weaknesses in terms of decision making for the fire manager.

The NFDRS was again revised in 1988. This time the revision corrected deficiencies in the performance of the system in the Eastern United States (Burgan, 1988). Because the problems driving the change were only in the Eastern US, the decision was made that the new version would be collapsible backward to the 1978 NFDRS to minimize complications for western users. The net effect was a more responsive system for eastern users and no change for those in the west.

In a general sense, the NFDRS serves two main purposes. First, based on current weather observations, it yields information about the current fire danger. When the proper prior analysis has been done it can tell the fire manager where the current conditions rate in terms of historical conditions. A second main purpose for the NFDRS is for predicting future conditions. This is done in conjunction with the fire weather forecasters of the National Weather Service. Each afternoon fire weather forecasters predict the values of the weather elements that affect fire danger for the next day (Deeming et al., 1977). This forecast is in turn used for the predicted NFDRS indexes and components for the following day.

Between the releases of the 1972 and 1978 versions of NFDRS, a fire behavior prediction system (FBS) was also developed (NWCG, 1985). The two systems, NFDRS

and FBS, were designed to be complimentary, each playing a unique part in wildland fire management. Bradshaw et al. wrote in 1983 that “The NFDRS was designed for low resolution, medium-to-large-scale applications; the Fire Behavior System (FBS) (Rothermel, 1983) was designed for high resolution, small-scale application” (p. 41). Basically, the NFDRS deals with fire danger over a large area and the FBS deals with the behavior of a specific fire.

Initially, the outputs of the NFDRS were generated manually. However, following four years of development the entire fire danger rating process was computerized in 1973 (Bradshaw et al., 1983). The Administrative and Forest Fire Information Retrieval and Management System, designated AFFIRMS, was available nationally on a time-share mainframe computer. Also, in 1973 the computer program FIRDAT was developed to process historical weather data through the NFDRS algorithms. The FIRDAT program was combined with two other computer programs, SEASON, and FIRINF, to create the FIRE FAMILY program. FIRE FAMILY took fire weather station attributes, and daily weather observations to generate frequency distributions, tables, and graphs of NFDRS indices and components (California Department of Forestry and Fire Protection [CDF], 1994). Between 1989 and 1992 the Weather Information Management System (WIMS) was developed to replace AFFIRMS (National Advanced Resource Technology Center [NARTC], n.d.). The WIMS program resides on a mainframe computer in Kansas City.

Because the computer programs available so far all resided on mainframe computers, access to them was difficult. To make access available to more users, several applications were adapted for use on personal computers. These applications include PCDanger, which does the same NFDRS calculations as WIMS does, and pcFIRDAT and

pcSEASON that provide FIRE FAMILY analysis on PCs (CDF, 1994). The Fire Information Retrieval and Evaluation System (FIRES) "...provides methods for evaluating the performance of fire danger rating indexes and for defining critical levels of fire danger (Andrews and Bradshaw, 1997, p. 2). FIRES allows the combination of historical NFDRS outputs with historical fire records. The historical fire record includes fire occurrence and final fire size as measures of fire activity. The FIRES program analyzes the relationship between fire danger indexes and fire activity to set fire danger intervals. These fire danger intervals can then be used for numerous management decisions relating to the severity of the fire weather.

Bradshaw et al. (1983) wrote that with the constantly evolving requirements of the NFDRS, up-to-date and knowledgeable users are a must. The NWCG (1985) wrote that the uncertainties and confusion relating to how to use the system must be eliminated. It is clear that a significant training effort must take place to better take advantage of the outputs of the NFDRS. The system is not something that can be learned in an afternoon or two. However, an excellent week long NFDRS course is available that provides a good starting point (NARTC, n.d.)

Perhaps the most significant contribution of the literature review was a statement made by Andrews and Bradshaw (1997, p. 26):

A primary use of fire danger rating is to track the fire season and assess the level of fire danger. ***The numerical value of a fire danger index for a single day holds little meaning. It takes on meaning when explained with respect to other days in the season, other years, percentile levels, or maximum, minimum, and average values for that time of year*** [emphasis added].

This statement by Andrews and Bradshaw must be understood and practiced by all users of the NFDRS. The comment on how to provide meaning to the values generated by the NFDRS serves as a goal for this research paper. Additionally, a lack of understanding of how to use the values generated, resulted in the problems with the initial attempt at restricting burning in the Amador El Dorado Ranger Unit.

PROCEDURES

Methodology

Various aspects of several research methodologies were used in this effort. A literature review was conducted that involved historical and descriptive research. The literature review proved especially helpful in gaining insight into the intended uses of the NFDRS and made it clear that, used correctly, it could be used to set burn day status based on fire weather conditions. The literature review also identified several computer programs that would assist in making appropriate decisions regarding fire danger.

A survey was conducted of all 21 CDF ranger units to determine if they restricted burning during hazardous fire weather. The survey (see Appendix A) was written using open ended questions to allow a wide range of responses. It was not practical to survey the numerous other wildland fire agencies across the country. However, an extensive search on the Internet was conducted to get a sampling of how debris burning and fire danger issues are handled in other states.

Evaluative research involved a significant amount of time analyzing historical fire and weather data using the FIRE FAMILY and FIRES programs. As previously stated,

there are 20 fuel models available in NFDRS. While not all of them apply in the Amador El Dorado Ranger Unit, there are several that could. Finding the correct fuel model(s) to represent the local fuels is most critical in getting reliable and useful results from NFDRS and the FIRES program. Additionally, NFDRS produces several indexes and components. The outputs each have different meanings; however, several could be used as a basis for restricting debris burning. An extensive examination was made of each of the outputs to determine which would be the best measuring device.

Limitations

One significant limitation of this research project was that limited fire and weather history was available. While records date back for decades, only the last 4 to 7 years, depending on the weather station, were available in a computerized format that could be analyzed. The same limitation affected historical fire data; only the last 7 years were available. Due to the normal variations in weather from year to year, it is recommended to have at least ten years of data for an analysis. Because fire occurrence is very much weather related, a minimum of ten years fire data is also recommended.

Another limitation faced in this effort was the computer programs. The programs are public domain, having been developed by government agencies. This does not necessarily make them less useful, but they have not kept pace with the current state of computer programming. While having them available on a PC has made their use much easier, they still leave a lot to be desired. The FIRES program especially is prone to crashing and does not take advantage of many of newer features available in PCs today. Additionally, FIRES does not exchange information as well as it could with the other programs available (Andrews, and Bradshaw, 1997). Several commercial programs were

identified during the Internet search; however, due to the expense they were not considered.

Definitions

Spread Component (SC). The spread model combines the influences of wind, slope, and fuel particle properties to predict the forward rate of spread of a fire. The slope and fuel type remain constant. Daily changes in wind and moisture content of the fuels make this a highly sensitive output.

Energy Release Component (ERC). The ERC is the estimated total potential energy available per unit area in the flaming zone of a fire. Daily variations in the ERC are caused by changes in the moisture content of the various fuels. The ERC is the most conservative of the outputs, that is, it varies only slightly on a day-to-day basis. The ERC does the best job of all outputs in tracing the seasonal trend of fire danger during the year.

Burning Index (BI). NFDRS combines the SC and ERC to generate the burning index. The BI measures fireline intensity and generally relates to the overall effort required to contain a fire. The BI also is scaled so that there is a relationship to the expected length of the flames at the head of a fire. Seasonal trends are traced reasonably well but the BI is more sensitive to daily changes in weather than the ERC.

Ignition Component (IC). The Ignition component rates the probability that a spark or ember will cause a fire that requires suppression effort. It is the most sensitive of all NFDRS outputs and is very time and site specific.

AFFIRMS. The Administrative and Forest Fire Information Retrieval and Management System. Mainframe based computer program used to calculate NFDRS indexes and components. No longer in use, replaced by WIMS in 1992.

WIMS. Weather Information Management System. Developed as a replacement for AFFIRMS. Based on a mainframe timeshare computer in Kansas City.

FIRDAT (pcFIRDAT). A computer program used to combine weather station attributes and daily weather records to generate NFDRS indexes and components. Generates data files used by other programs for additional analysis. A version for personal computers is available (pcFIRDAT).

SEASON (pcSEASON). A computer program that uses files generated by FIRDAT to further evaluate NFDRS variables. A version for personal computers is available (pcSEASON). Analysis is limited to one variable at a time in the mainframe version.

FIRINF. A computer program that uses files generated by FIRDAT to further evaluate any two NFDRS variables. This feature is included in the pcSEASON program.

FIRE FAMILY. A family of computer programs primarily used for evaluation of historical fire weather for long range planning. Included are the FIRDAT (pcFIRDAT), SEASON (pcSEASON), and FIRINF programs.

FIRES. Fire Information Retrieval and Evaluation System. A PC based computer program used to evaluate the performance of fire danger rating indexes. Compares historical weather records with historical fire records. Seasonal trends of fire danger and fire occurrence are analyzed and presented in a graphical manner.

RESULTS

The results of this project go far beyond just answering the research questions. The analysis allowed by the FIRES program provided a much better understanding of fire danger rating in general and specifically how it could be applied within the Amador El Dorado Ranger Unit.

The answers to the research questions are as follows:

Research Question 1. What are other CDF Ranger Units doing about burn days during hazardous fire weather conditions?

Only seven responses were returned. While not enough were returned to make it a statistically valid survey, there were enough to get a general idea what some other ranger units are doing regarding debris burning. The State of California is divided into two CDF regions. These regions are generally north and south. Each region is further divided into two areas. While CDF is one department there are significant differences in management from one end of the state to the other. The survey conducted of CDF Ranger Units reflected one of the differences. The Cascade Area of the Northern Region implements an area wide ban on all household debris burning from July 1 until November 1 each year. In the southern region no such area or region wide policy exists.

No ranger units were identified that used NFDRS on a daily basis to restrict burning. Two units do restrict burning based on the Burning Index, but only when conditions are predicted to last for several days. It was also clear that there was a general poor understanding of the potential uses of the NFDRS.

An Internet search was conducted for information on how other states are handling debris burning and fire danger considerations. Several states were found that had systems that were similar to California's. A few states had programs that were significantly different. In Washington, state law limits burning to just 14 days a year and will further limit the number of days to seven in 1999. The specific days are predetermined; however there is still criteria for restricting burning under windy conditions (Spokane County Air Pollution Control Authority, 1998).

A truly state-of-the-art system is being developed in Florida. A cooperative effort between the Florida Division of Forestry, and University of Florida is developing a "Enhanced Open Burning Authorization and Wildfire Suppression System" (Florida State University, 1998, p. 10). The system being developed uses the NFDRS, aspects of the Canadian Forest Fire Weather Index System, and a system of 110 weather stations. Computers are networked statewide and requests for burning are immediately analyzed based on fire danger, smoke dispersion, and numerous other considerations.

Research Question 2. What information is available to gain a better understanding of the National Fire Danger Rating System and use it to its full potential?

As the literature review revealed, there was an abundance of information available about the NFDRS. A great deal of information was compiled and examined. There did not appear to be a singular book, or even a handful of books, which tell all the details of the NFDRS. Bits and pieces were scattered throughout the references examined.

A prototype system currently in use in Oklahoma is a next-generation version of NFDRS (Oklahoma State University, 1998). Oklahoma State University developed the

Oklahoma Fire Danger Model in conjunction with the Intermountain Fire Sciences Lab of the US Forest Service. A major advancement is that the system uses a real-time automated weather station network in place of the once-a-day weather observations of the current NFDRS. The system produces 1-km resolution colored maps showing fire danger ratings four times a day.

Research Question 3. What tools are available for evaluating fire weather and fire danger conditions?

Several computer programs were found that can assist in analyzing historic fire and weather data for a better understanding of how weather affects fire danger. The FIRES program was by far the most helpful of the tools identified. FIRES and pcFIRDAT work together on a PC to give the user the ability to make educated management decisions regarding fire danger related issues. Both programs were used in answering research question 4.

Research Question 4. What weather conditions allow debris burning in a safe manner?

Analysis of historic weather and fire data was conducted using the FIRES program. This program allows the user to compare several different fuel model options with different NFDRS outputs. The analysis revealed the fire danger conditions where fires historically occurred. Additionally, the analysis showed at what point large fires or multiple fires occurred. The FIRES program allows the user to set the point at which it defines large and multiple fires. The ability to analyze conditions that contribute to large fires proved especially helpful. The analysis showed that wildland fires have occurred in virtually all weather conditions. Generally, the fires which occur under cool and clam conditions are

more of a nuisance than a threat. Large fires require more resources and pose a more significant threat. The analysis of when these larger fires occurred served as the primary basis for the recommendation of when to restrict debris burning.

As stated, the FIRES program analyzes historical fire and weather records. This analysis serves several purposes. The most significant, and simplest, is seeing, in a graphical format, the relationship between fire occurrence and fire danger indexes. A far more complex purpose of the analysis is determining the best fuel model and index or component to use. Andrews and Bradshaw (1997) on page 47 of their publication give a list of the steps to take in choosing the most appropriate fire danger index and fuel model. These steps served as the basis for the selection of Fuel Model C (Woodland/Grass) as the best fit for the data analyzed. Two NFDRS outputs were also selected, the BI and ERC. The BI gives a better indication of current fire danger, yet its sensitivity makes its forecast for the following day less reliable. The ERC is more stable than the BI and makes it better for using with the next day's forecast.

The FIRES program allows the user to establish up to five different break points for the indexes analyzed. In this case only one break point was needed, the point at which burning would be cut-off. Two goals were kept in mind while determining where the cut-off should be. First was to have as many of the large fires as possible occur above the cut-off point. Second was to allow as many burn days as possible. A cut-off point for burning using the ERC and fuel model C was established at 14. Based on the historical weather data, 45% of all days were below the cut-off. Based on the historical fire data 87% of all fires 20 acres and larger occurred above the cut-off. See Appendix B for the FIRES decision point output screen showing the cut-off for the ERC. For the BI in fuel model C the

cut-off point was established at 26. The data showed that 49% of all days were below the cut-off and 85% of all fires 20 acres and larger were above that point. See Appendix C for the FIRES decision point output screen showing the cut-off for the BI.

DISCUSSION

The literature review indicated that the NFDRS was very well suited for making management decisions. Deeming et al. (1977) indicated that producing information for planning was the principal objective of the NFDRS. The investigation report of the firefighter fatalities on the South Canyon Fire in Colorado in 1994 stated that fire danger levels should be compared to historical averages and worst case conditions (U.S. Department of Agriculture, Forest Service, 1994). It was clear from the literature that, if used correctly, the NFDRS would be an excellent tool for managing the burn day status in the Amador El Dorado Ranger Unit.

The results of the analysis conducted using the FIRES program were impressive. This author has more than 25 years experience in wildland fire control, nearly half of which is in the local area. Experience gives a firefighter a sense of how weather and fires relate.

The visual presentation of historic fire and weather data combined served to reaffirm many years of firefighting experience. Additionally, both active and slow fire seasons of the past could be viewed on the computer and served

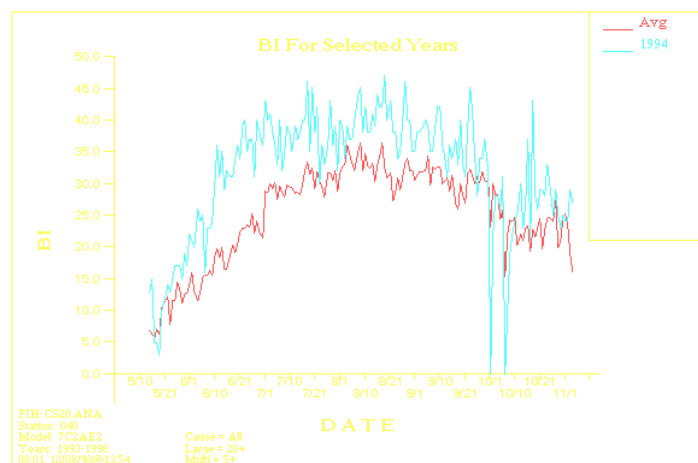


Figure 1. BI for an Average year and 1994

to give not just the computer program, but the entire NFDRS process further credibility (See Figure 1).

Amador El Dorado Ranger Unit will gain significant credibility by implementing the NFDRS. Management will benefit by taking advantage of the assistance the system can provide in its decision-making role. By implementing the burn day cut-off points developed, burning will only be restricted when the fire danger truly warrants it. The public, as well as other governmental bodies, would be able to see that burning is based on scientifically demonstrable criteria. The response by other ranger units to the survey indicated that others might also benefit by taking advantage of the capabilities of the NFDRS.

RECOMMENDATIONS

Analysis of data using the FIRES program generated proposed cut-off points for debris burning using two different NFDRS outputs. The BI and ERC have individual strengths and weaknesses. If the burn status is to be based on the forecast for the next day the ERC should be used. However, if the burn status is to be based on current observations then the BI should be used. Regardless of which output is used it should generate better results than those of the current method.

As stated in the Limitations Section, there is a shortage of historical fire and weather data. The combined lack of experience in the NFDRS and shortage of data mean continued evaluation needs to take place. The cut-off point for burning should be monitored during the course of the next fire season and may need to be modified as

additional data and experience are gained. Only time can correct the problem of historical data, more data will be added to the database on a daily basis.

The command center (dispatch) personnel, where the NFDRS outputs are produced, should keep track of all outputs, not just the BI and ERC. Keeping all outputs will make them available for further study and analysis. Management will be able to see how the other indexes and components produced by the NFDRS relate to the ones chosen for the burn day status.

NFDRS is a valuable tool and has numerous applications that could be taken advantage of, with sufficient training. Additional personnel in the ranger unit need to be trained in the NFDRS. The priority for training must be with command center personnel, as they will be working with the system on a daily basis. Additionally, all chief officers should have training in the NFDRS. All other personnel need to have at least a basic understanding of the NFDRS and how it relates to firefighting. Most unit personnel now have little knowledge of the system and do not really understand the meaning or value of an index or component. As was previously indicated, Andrews and Bradshaw (1997, p. 26) stated:

The numerical value of a fire danger index for a single day holds little meaning. It takes on meaning when explained with respect to other days in the season, other years, percentile levels, or maximum, minimum, and average values for that time of year.

All personnel involved in wildland fire control must understand this quote and managers must be able to put it into effect.

Two additional areas appear to warrant further study. First is the system being developed in Florida. The GIS based fire management system in use, and under further development, by the Florida Division of Forestry has several applications that could benefit CDF and other wildland fire agencies. Even more interesting is the Oklahoma Fire Danger Model. Maps of the state are available on a real-time basis on the Internet. These maps show fire danger indexes, live and dead fuel moistures, and the Keetch-Buram Drought Index.

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APPENDIX A

CDF Ranger Unit Survey Restriction on Burn Day Status

I am preparing a research paper for a course at the National Fire Academy and would appreciate your assistance. I have just a couple simple questions. Specifically what I am working on is a method of overruling the ARB when the determination is made that it is a burn day, and yet we don't want people burning due to fire danger.

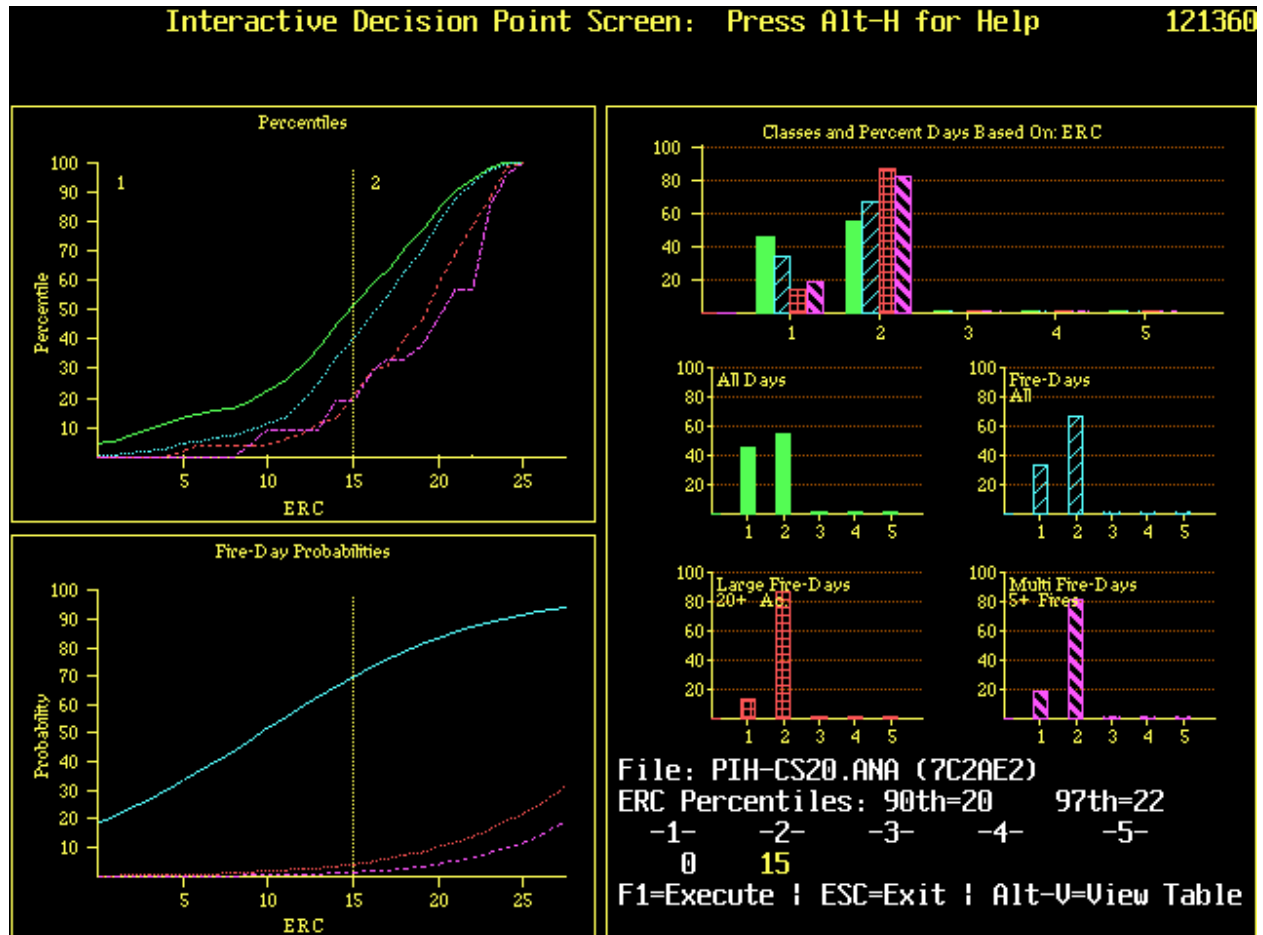
1. Do you have any restrictions on debris burning during fire season, other than those imposed by the Air Resources Board?
2. If so please describe how they are implemented and what factors are considered in the determination.
3. What is the duration of any restrictions?
4. Do you use any tools (computer programs) in determining?

A prompt reply via email would be appreciated. Thank you for your time and effort.

Jody Gossner, AEU

APPENDIX B

FIRES output for Energy Release Component cut-off



APPENDIX C

FIRES output for Burning Index cut-off

Interactive Decision Point Screen: Press Alt-H for Help

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